height, measured respectively 0·065 by 0·051 inch, 0·437 by 0·562 inch, and a spherical one had a diameter of 0·5 inch." Such large hailstones are, I believe, rarely met with in storms near London. This one seems to have been confined to a comparatively small area, the hail falling in its greatest severity at Leyton, and not extending much beyond Walthamstow, Stratford, West Ham, and here.

B. J. HOPKINS.

Forest Gate, E., June 22.

"An Alphabet of Motions."

I HAVE lately found the following extract in Arthur Young's "Travels in France, in 1787," which I fancy is not generally known. It occurs in Betham Edwards's late edition (Bell and Sons), at p. 96.

"In the evening to Mons. Lomond. . . In electricity he has made a remarkable discovery. You write two or three words on a paper; he takes it with him into a room and turns a machine inclosed in a cylindrical case, at the top of which is an electrometer, a small fine pith ball; a wire connects with a similar cylinder and electrometer in a distant apartment; and his wife, by remarking the corresponding motions of the ball, writes down the words they indicate, from which it appears he has formed an alphabet of motions. As the length of the wire makes no difference in the effect, a correspondence might be carried on at any distance."

J. S. DISMORR.

Stewart House, Wrotham Road, Gravesend, June 24.

On a Cycle in Weather Changes.

IT is known that Prof. Brueckner, of Berne, in a work on "Klimaschwankungen," published a short time ago, offers a large amount of evidence for the view that our globe is subject to a weather-cycle of about 35 years, a series of cold and wet years, or warm and dry ones, recurring at about that interval. Has it been noticed in this connection that Bacon, in one of his essays (No. lviii. "Of Vicissitude of Things"), makes reference to such a cycle? The passage is as follows:—"There is a toy which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the Low Countries (I know not in what part) that every five-and-thirty years the same kind and suit of weathers comes again; as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like, and they call it the *prime*. It is a thing I do the rather mention, because, computing backwards, I have found the same concurrence."

A. B. M.

THE FORECAST OF THE INDIAN MONSOON RAINS.

AFTER an interval of twelve more or less prosperous years, following on the memorable Madras famine of 1876–77, and the drought and fearful mortality of North-Western India in 1877–78, India seems once more to have entered on one of those prolonged series of adverse seasons which put a severe strain on the protective powers of its Government, and, despite all human precaution, bring suffering, disease, and premature death to thousands of its industrious peasants, and to even larger numbers of the impoverished outcasts who form the lowest fringe of its teeming population, fighting the precarious battle of their life at all times on the verge of destitution. The drought in Ganjam in the autumn of 1889 has been followed by the failure of the late autumnal rains over the central districts of the Carnatic towards the close of last year, and the too familiar machinery of relief works for the able-bodied, and doles of food to the helpless indigent, has been in active operation for several months past in the districts around Madras. Another monsoon, another season of those periodical rains on which depends the fate of millions, is now due and overdue, and there comes from India an ominous note of warning that there is reason to fear that more than one great province of the empire, or certain portions of them, may again this year lie parched and barren, their young crops withering and shrivelled under the dry west wind, while, month after month, men scan with ever-growing anxiety the pale dust-obscured sky and scattered ball-shaped clouds that never mass themselves to rain-clouds, but mock their hopes with the promise of showers that never fall to moisten the sun-baked soil.

And this warning, alas! is no mere guesswork of credulous and speculative minds, such as in these latitudes certain of our would-be weather prophets love to put forth at hazard, to furnish the topic of a day's gossip to the million, or haply to win for themselves a summer day's reputation with the uninstructed, in the event of a successful issue. Certainty, indeed, there is not and cannot be till science shall have extended its domain far beyond its present limits; but, in India, the stately march of the seasons is but little obstructed by the vicissitudes of fugitive cyclones and anticyclones, that originate we know not how, and disappear by some concurrence of causes equally beyond our ken. In the tropics, and in the realm of the monsoons, all weather phenomena are more massive and slower in progress, and each great change of seasons is heralded by signs which, if we can as yet but vaguely interpret them, are at least recognizable as such, and, with a certain allowance for possible error, must be accepted as timely monitors of what is likely to follow. These it is that, whether rightly or wrongly deciphered, furnish the basis for the present warning. To those who, like the present writer, have followed for many months past, not without anxious interest, the telegraphic and other reports periodically transmitted from India, it comes as no surprise, but as a confirmation of misgivings long entertained though only now backed by the warranty of full official evidence. The events of the next three months may yet belie the present indications, and that they may do so is still our fervent hope; but it would be folly to ignore them, and to shut our eyes to the probabilities that they seem to portend.

For the last eight years it has been one of the duties of the Indian Meteorological Department, some time early in June, to prepare, for the information of Government and the public, a forecast of the probable character of the summer monsoon, based on the reports of the snowfall on the Himalaya and the western mountains, and on the indications afforded by the weather of the previous winter and spring. The possibility of framing such a forecast was in a measure foreseen by the Famine Commissioners appointed by the Home Government after the disastrous famines of 1876 and 1877, of which Commission General R. Strachey, the true founder of the Meteorological Department of India, was the scientific member; and it is in no small degree due to the weighty advocacy of this Commission that the Department owes its present extension and importance. Mr. Eliot's forecast for the coming season is now before us. It sets forth at length the general and special grounds on which he bases his conclusions; and these, though duly guarded by the reminder of their essentially empirical character, and of the unavoidable imperfection of our information regarding certain important data, are expressed in terms that leave unhappily no doubt of the adverse character of the outlook.

Attention was first directed to the apparent connection of the Himalayan snowfall with the prevalence of dry land winds in India, in the year 1877, and about the same time the late Prof. S. A. Hill and Mr. Douglas Archibald showed that, as a general rule, an unusual cold weather rainfall in Northern India was followed by a deficient rainfall in the ensuing summer monsoon. In a paper published in the Proceedings of the Royal Society in 1884, these two classes of facts were shown to be merely different phases of the same phenomenon, and a summary was given of all the evidence on the subject that had been accumulated up to that date. Since then, there has been but one year of heavy Himalayan snowfall, viz. 1885, and in that year the rains were greatly delayed on the Bombay coast, and were very deficient in North-Western India in June, July, and September, commencing late, and terminating early. During the past winter and spring the snowfall on the North-Western Himalaya and the mountains of Afghanistan and Baluchistan has been excessive—indeed, as Mr. Eliot states, unprecedented during the last twenty-five years—and from the reports received from the civil officers and observatories in the mountain districts, he estimates that an average fall of 40 feet, if not considerably more, must have fallen over all the higher ranges, from Murree eastward to Garhwal, if not to Central Nepal. That it was the same on the less accessible range of the Hindu Kush we have reason to believe from the casual reports that were received during the last winter, and we know that in Southern Europe and even in Northern Africa, snow fell down to the sea-level, and was such as has hardly been experienced certainly during the greater part of the present century. The phenomenon has therefore been one of widespread incidence, and indicates some remarkable and rare condition of those higher strata of the atmosphere which, we have now reason to believe, are the seat of the more important changes that regulate the vicissitudes of the weather of the globe.

Concurrently with this exceptional extension of the snowfall to low latitudes of the temperate zone, the Indian registers afford evidence of certain abnormal features, which are such as have been noticed on former occasions of unusual snowfall on the North-West Himalaya, and the bearing of which on the weakness of the summer monsoon is more clearly traceable. In fact, they tend to link the two phenomena together, whether we regard them as the common effects of some more remote agency, or as displaying the different steps of a physical sequence of cause and effect. The most important of these are: the unusual rainfall over the whole of Northern India in the past winter and spring, amounting to from two to three times the average in the Punjab, where it was heaviest; a prevailing low temperature in Northern and especially North-Western India, together with a corresponding excess of temperature in Assam, Burma, and Southern India; and finally, a persistent excess of atmospheric pressure in the former region and a deficiency in the latter. These anomalous features have characterized more or less all the months of the present year, especially March and May. As estimated by European standards, the anomalies of this last element may indeed appear small. For instance, the mean excess at Peshawar in May was 0·052 inch, at Mooltan 0·041, and at Quetta 0·049 inch, while the deficiency at Calicut was 0·040 inch, and at Sibsagar 0·031 inch. Taken together, they constitute an anomalous gradient from north-west to south and east of something under a tenth of a barometric inch in distances of 1300 and 1500 miles. But in India such differences are relatively large, and, as former experience has abundantly shown, very significant. As temporary phenomena they might indeed be of little importance; but, lasting as they have done through nearly half a year, they point to an anomalous state of the atmosphere which is evidently persistent, and is distinctly adverse to the northern incursion of the summer monsoon. Taking the general mean of all parts of the empire, the atmospheric pressure has been above the average in every month of the present year. With respect to the winds, Mr. Eliot remarks:—"South-easterly winds have been unusually prevalent in Bengal and Behar during the months of April and May, and north-westerly and northerly winds on the west coast of India as far south as Cochin. The unusual prevalence of north-westerly winds on the Bombay coast in the month of May was one of the features of the weather in 1876, 1883, and 1885, in which years the monsoon was greatly retarded on that coast."

Finally, after reviewing the chief characteristics of other years in which the Himalayan snowfall has been heavier than usual, Mr. Eliot draws the following conclusions with respect to the probable character of the monsoon rains of the present year in the different provinces of India:—

"(1) Snowfall conditions on the Western Himalayas, &c., and the pressure conditions in India are very unfavourable to the establishment of a strong and early monsoon on the Bombay coast. It is very probable that it will not be established in full strength on the Bombay coast before the third or fourth week in June, and it is probable that it will be below its average strength, and may be withdrawn from Upper India earlier than usual in September.

"(2) The snowfall conditions in the Eastern Himalayas, and the pressure conditions in North-Eastern India and Burma, are favourable to the advance of a moderately strong or strong monsoon in the Bay of Bengal earlier than usual, and to its establishment in Burma and Bengal before or about its normal period," and Burma, Bengal, and Assam are expected to receive an average or more than an average rainfall; Behar and the eastern districts of the North-West Provinces about the usual amount. In Southern India it is thought probable that the rains may be retarded, but that Malabar and Southern India generally are likely to receive favourable rain during the monsoon.

On the other hand, it is pointed out that "conditions are very unfavourable for Rajputana, and also to some extent in Guzerat, the southern districts of the Punjab, and the western districts of the North-West Provinces. It is probable the rainfall will be more or less deficient over the whole of that area, and possible that the deficiency may be large and serious." In Northern Bombay and Berar it is thought that "the rainfall is more likely to be slightly deficient than up to its normal amount," and that in the Central Provinces it will be "fairly normal."

From this abstract it will be seen that the region in which drought is chiefly to be anticipated is the western provinces of Northern India, comprising Rajputana, Guzerat, the southern districts of the Punjab, and the western districts of the North-West Provinces; provinces the average rainfall of which does not exceed between 20 and 30 inches, and which time after time have been the seat of disastrous famines. Now there is one consideration relevant to this subject of which no mention is made in Mr. Eliot's report, and which, notwithstanding that its bearing is purely empirical, cannot, we think, be entirely disregarded when dealing with the question of probabilities. This is the fact, first pointed out by the Famine Commissioners, that between 1782 and 1877, on no less than five occasions, a drought in Southern India was followed by a drought in Northern or rather North-Western India in the succeeding year. It does not seem possible, in the present state of our knowledge, even to suggest any physical explanation of this remarkable sequence, but it has been repeated too often to allow of our regarding it as purely fortuitous, and unfortunately it only tends to strengthen the probability of the adverse conditions inferred by Mr. Eliot from the existing state of things.

It must be confessed, then, that, according to our present means of judgment, the present outlook is by no means hopeful. The mere fact of a retardation of the monsoon rains would not in itself afford cause for serious anxiety. According to the latest report from Madras, indeed, this part of Mr. Eliot's forecast seems to have been justified by the event, for on June 26 the Governor of Madras telegraphs that the south-west monsoon rains have not set in properly in the interior, and are very light even on the Malabar coast,[1] whereas the date at which they are usually expected is the end of May or the beginning of June. The really critical months in North-Western India are August and September. If the rainfall is then abundant and continuous up to the end of the third week in September, with a final shower or two at the end of the month, all may yet be well; but if the rainfall of these months is light and partial, and if it ceases prematurely, the crops form no ear, and they perish and dry up in the warm dry west winds that speedily follow. And it is these crops that furnish the food staples of the agricultural classes of India. H. F. B.

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[1] We have taken the liberty of altering the punctuation of this telegram to bring it into accordance with sense and fact.

PHYSICAL SCIENCE FOR ARTISTS.[1]

II.

WE next come to the absorption of light. I do not know whether you have had any opportunity yet in your laboratory course of observing the spectral phenomena produced when white light, or say solar light, is absorbed by different substances. The white light is broken up by the dispersion of the prisms into a rainbow band; while it is possible, by one means or another, one substance or another, to filch out of this coloured band some of the constituent colours, now at one end, now at another, sometimes in different parts at once; and when this has been done, the light which finally reaches the eye may be of any colour, as is evidenced by the different colours you see in a stained glass window. This is what happens also by the absorption of our atmosphere, due in all probability in great part to the contained aqueous vapour. The sun is white in the middle of the day and red at sunset. The blue part of the light, which, when all the colours reach us, looks white, has been taken away, and practically nothing but red is left; only certain parts of the spectrum are left. It is easy, after two or three hours' experiments with the absorption of light by different media, to grasp the laws which govern sunset colours precisely, as it is easy in the anatomical school to study the facts relating to the human form, particular muscles and the like. A diligent student will thus have the world of colour at his feet. This can, however, only be done by one interested in physical science, and I think it should be done by anyone who wishes to deal with landscapes or seascapes, anything, in fact, which has to do with the natural world. The results obtained in this way of course come to us pictorially, chiefly in the colour of sky and water and in the colours of clouds, and they are mixed up in pictures by the knowledge, or want of knowledge, of the artist who paints these various reflecting surfaces. The reflecting surface, whether water or cloud, or what not, must not only be true in colour, but perfectly formed, in order to give an absolutely perfect and pleasant picture.

Here I think it is that the need of physical science is greatest, and I do not know, in fact, that there ought not to be some kind of an examination in a College like this which shall insure that anyone who is going to take up the study of art is not colour-blind. This is done in the case of sailors and engine-drivers, and I think it should be done in the case of artists. There are pictures which have apparently been painted by colour-blind people; and of course it should be a subject of great regret that so much skill has been wasted in consequence of such a malformation as this.

It may be, of course, that in some cases, where the thing may be charitably supposed to arise from a physical defect, it is the result of mere ignorance, or want of observing power; but if that be so, then my point is proved, because it is clear that a good scientific training will cause these objectionable, impossible, colours to be gradually eliminated from our exhibitions. On the other hand, when we look at a gallery of pictures, one is so frequently rewarded by the exquisite truth of some of them, that one could very well look over the defects of others, if all thoughts of the possible progress of art achievement were banished from one's mind.

Some of you may perhaps have read Mr. Ruskin's chapter on clouds. The scientific basis of the various cloud forms, however, you will not find there. Now when we consider that in land- and sea-scapes the sky, and especially the clouds, are among the most important reflectors of light, whether white or coloured, the form of the cloud is absolutely of very high importance. If the light is reflected by an absolutely impossible cloud, your delight at the colour, which may be true, is absolutely checked by the treatment of the anatomy of the cloud. Here, again, we touch a distinct branch of physical science. An acquaintance with the various forms of condensation assumed by aqueous vapour under the various conditions of the atmosphere would certainly keep one right where one would be very apt to go wrong. I referred, also, to the reflection of sunlight, whether white or coloured by absorption, by water. Here, I think, is a region where physical science is also helpful. There can be no question that the grandest display of colour in the natural world is a sunrise or sunset, either at sea, or where there is a water surface to bring in a second series of reflection phenomena. As a rule, perhaps, if the water be somewhat land-locked, or at all events not broken up by strong wind, the effect is finer, and this perhaps is one of the reasons, but only one, why the sunsets seen off the west coast of Scotland are so remarkable.

This, however, does not always hold. I have seen a sunrise in the Mediterranean when passing the Straits of Gibraltar twenty years ago, which was so magnificent, that not only is it still present in my mind's eye, but all the sailors who were swabbing the deck at the time ceased work and simply gazed at it entranced. It promised to be a cloudy sunrise, but suddenly the cloud pall melted into mackerel sky, and the sun at rising payed out different colours on the high and low patches; the sea was choppy, and every facet of every wave, and every facet of a facet, being turned to different parts of the sky; these picked up and reflected to the eye different colours, so that every wave looked like a casket of gems.

The red or yellow colours on the clouds depend simply upon the thickness of the atmosphere which the sunlight has traversed to reach them; the colour depends absolutely upon the light received from the sun, and it has nothing to do with the apparent angular distance from the sun in your picture; but while all this change is going on in the clouds the sky itself will be zoned above the horizon from the red to the blue overhead, and in addition to that, you will get the greater luminosity nearer the sun's place. But further than that the sky will not go, because it cannot. At the same height above the horizon you must have absolutely the same sky colour. Now that is a very obvious conclusion. You will always note the greatest possible distinction between the colour of the pure sky and of the clouds. A favourite *sky* colour in sunsets is green. I have seen no green *clouds* except in pictures.

I have noted a few of those pictures this year, which, in my opinion, and I only give it for what it is worth, are remarkable for their truth, or for the absence of it, in different degrees. The numbers are those of the Royal Academy Catalogue, unless otherwise stated:—

Clouds.—Good colour, 351.
Good form, 288, 600.
Good colour and form, 238.
Water.—Good colour, 630, 1029.
Good surface, 682, 759, 1013. New Gallery, 102, 120.

With great deference I must, until convinced to the contrary, hold that much of the colour in the following

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[1] Continued from p. 178.